METHOD FOR FORMING PI-TYPE ASSISTANT ELECTRODE

BACKGROUND OF THE INVENTION

Field of the Present Invention

The present invention relates to a method for forming π-type bus electrode, and more particularly, to a method for improving the adhesion capability between the π-type bus electrode and indium tin oxide (ITO) electrode.

Description of the Related Art

Indium is a kind of rare metal. It is similar to silver, yet the quantity of which in the crust is about 5-10%, only 1% of that of silver. In nature, indium exists in mixture with other mineral substances in very small quantity. Now about fifty kinds of mineral substances are discovered to contain indium, in which lead zinc minerals that contain sulfur has the largest quantity of indium while tinstone, wolframite, and ordinary uralite also contain a larger quantity of indium. Besides, some dust produced by thermal power plants also contains indium. At present the mineral substance that is worth industry recycling is mainly sphalerite. In general, sphalerite contains about 0.001% to 0.1% of indium.

Indium is a metal that is silver white and a little light blue, softer than lead in its hardness, the melting point of which is about 156.6℃ and the density of which is about 7.3g/cm^3. It has good expandability, conductivity, and plasticity, and is able to be pressed into an extremely thin slice. Indium has chemical properties similar to those of iron, slowly reacting to oxygen in the air between normal atmospheric temperature and its melting point and forming very thin oxide film on its surface. Indium has very good anti-corrosiveness to seawater and reflectivity to light, being able to reflect almost all the colors on the spectrum. Besides, indium can form alloy with many other kinds of metal such as Ag-Pb-In alloy that can be material of bearing of high-speed aero-engine and Indium-Tin alloy that can be vacuum airtight material, material for contact of alloy of low-melting point, or binding material between glass and glass or glass and metal.

So far in the industry, the largest market of application of indium is function material. In general, indium is used in the form of indium tin oxide as transparent electrode that serves as display panel, which is widely applied in thin film transistor, liquid crystal display panel or plasma display panel.

Referring FIG.1A, a top view of a layer of indium tin oxide transparent conductive film 102 formed on a glass substrate 100, in which the portion of slashes is glass substrate 100 and the other

portion is ITO transparent conductive film 120. ITO (indium tin oxide) transparent conductive film 120 is formed on glass substrate 100 by methods such as Thermal Evaporation Deposition, sputtering, Electron Beam Evaporation, Spray Pyrolysis, Chemical Vapor Deposition, and Pulsed Laser Deposition. In these methods, sputtering process has merits such as being able to form film of large square measure, film of even thickness, and reproducible thin film and is a process that is widely used at present. And through adjusting the parameters of film forming in sputtering process such as distance between target material and glass substrate 100, thickness of thin film, and conditions of sputtering, the properties of ITO transparent conductive film 120 can be precisely controlled.

Then, conductive layer as bus electrode such as silver paste is formed on ITO electrode 102 and glass substrate 100 by print method. A π-type (or referred to pi-type) bus electrode 104 is then formed by lithography method, the pi side 106 of the pi-type bus electrode 104 being on ITO electrode 102 and portion of stripes 108 of the pi-type bus electrode 104 being on glass substrate 100, as shown in FIG.1B.

Since pi-type bus electrode 104 is composed by silver and small sum of glass powder, there is good adhesion capability between portion of stripes 108 of the pi-type bus electrode 104 and glass substrate 100 but worse adhesion capability between pi side 106 of the pi-type bus electrode 104 and ITO electrode 102. Therefore, edge warp

phenomenon of the pi side 106 of pi-type bus electrode 104 will occur, as shown in FIG.1C. And the edge warp phenomenon the pi side 106 of pi-type bus electrode 104 will cause point discharge effect of pi-type bus electrode, which hinders the following process to proceed.

In conventional art, a layer of edge warp preventer, which is not shown in the figure, is formed on pi-type bus electrode 104 before it is put under firing process to prevent edge warp phenomenon 110 of pi side 106 of pi-type bus electrode 104 from occurring when ITO electrode 102 and pi-type bus electrode 104 are under firing process. Although a preventer can be used to prevent pi-type bus electrode from edge warp phenomenon, yet the cost is high and the process has complicated steps, which are the disadvantages of conventional solution.

SUMMARY OF THE INVENTION

The main purpose of the invention is to improve the adhesion capability between pi-type bus electrode and ITO (indium tin oxide) electrode.

Another purpose of the invention is to prevent the pi side of pi-type bus electrode from occurring of edge warp phenomenon.

Still another purpose of the invention is to prevent from the point

discharge effect of electrode.

And still another purpose of the invention is to simplify the complicated steps of the process and lower the cost of the process.

According to the purposes described above, the present invention provides a method for improving the adhesion capability between the π-type bus electrode and ITO electrode. The method includes an ITO transparent conductive layer as an ITO electrode is formed on the glass substrate by sputtering method. Then, a photoresist layer with a cavity pattern is formed on the portion of the ITO transparent conductive film. Next, a wet etching process is used to remove portion of the ITO transparent conductive film to form ITO electrode and also a cavity within the ITO transparent conductive film and to expose part of the glass substrate. Then, after removing the photoresist layer, a conductive layer as a bus electrode is formed on the glass substrate and on the ITO electrode by print method. Then a pi-type bus electrode is formed by lithography process, the pi side of the pi-type bus electrode being on the cavity on exposed portion of glass substrate and portion of stripes of the pi-type bus electrode being on glass substrate. Since there is good adhesion capability between pi side and exposed glass substrate, the adhesion capability between pi side of pi-type bus electrode and ITO electrode is also improved. Therefore, there will be less edge warp phenomenon and the point discharge effect will not occur.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1A to FIG.1C are the diagrams showing the structure of pi-type bus electrode in different steps of process of conventional art in which edge warp phenomenon occurs; and

FIG.2A to FIG.2C are the diagrams showing the structure of pi-type bus electrode in different steps of process according to the technique disclosed in the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Some embodiments of the invention will be described in detail in the following. However, besides the detailed description, the invention can also be applied widely in other embodiments and the application scope of the invention is not limited but confined by the appended claims.

TFT technique or color twisted nematic technique are used in all the color liquid crystal display panels with high resolution, and the key material of these two kinds of monitors is indium. In the producing process of liquid crystal display panel, a very thin layer of ITO (indium tin oxide) is sputtered on glass, this ITO being called cathode sputtering, which can turn the glass into color display panel. ITO is

usually used as sputtering electrode material, the essence of which is ceramic material.

Referring to FIG.2A, according to the invention, the glass substrate 10 in prior art is used as base material, and this glass substrate 10 can be divided into two kinds, one using indium metal (or indium-tin alloy) as base material, and the other using indium oxide (or with small sum of tin oxide) as base material. In the former case, methods such as reactive evaporation, reactive sputtering, or reactive ion film forming can be used; in the latter case, vacuum evaporation, high frequency sputtering, or PECVD can be used.

Then, ITO transparent conductive film 12 is formed on glass substrate 10 by sputtering method, forming a pattern as shown in FIG.2A. In the diagram, portion of slashes is glass substrate 10 and portion without slashes is ITO transparent conductive film 12.

Then is one of the main features of the invention. Referring to FIG.1B, photoresist layer with pattern of cavity (not shown in the drawing) is applied and formed on ITO transparent conductive film 12. A portion of ITO transparent conductive film 12 on glass substrate 10 is then removed by wet etching method to form ITO electrode and ITO transparent conductive film 12 on pattern of cavity is also removed to expose portion of glass substrate 10 to form a cavity. The step of forming cavity 14 is to keep good adhesion capability between pi-type

bus electrode formed in the following steps of the process (referring to FIG.2C) and glass substrate 10 and therefore improves adhesion capability between pi-type bus electrode 16 and ITO transparent conductive film 12.

Referring to FIG.2C, after photoresist layer is removed, glass substrate 10 with ITO electrode 12 is put under drying process, and conductive layer of pi-type bus electrode 16 such as silver paste is formed on glass substrate 10 and on ITO electrode 12 by print method. Then, a pi-type bus electrode is formed on ITO electrode 12 in lithography step. Wherein, two sides 18 of pi-type bus electrode 16 are formed on cavity 14 formerly formed in the etching process to remove ITO transparent conductive film 12. Since pi-type bus electrode 16 composes about 70% of silver and small sum of glass powder, the adhesion capability between pi side 18 of the pi-type bus electrode 16 and glass substrate 10 exposed in cavity 14 is good and the edge curl phenomenon will not occur. Besides, portion of stripes 20 of pi-type bus electrode 16 is located on glass substrate 10. Since the adhesion capability between the whole pi-type bus electrode 16 and ITO electrode 12 is improved, edge curl will not occur on pi side 18 of pi-type bus electrode, and point discharge of pi-type bus electrode will be decreased, and therefore the following steps of the process can proceed.

According to the description of embodiment above, we can

conclude that the merit of the invention is to change mask pattern that is used to form ITO transparent conductive film on glass substrate in the step of forming ITO electrode in lithography process, thus when the ITO electrode is formed, portion of ITO transparent conductive film is removed to form a cavity for exposing portion of glass substrate. Therefore, pi side of pi-type bus electrode formed in the following steps can adhere to the glass substrate and edge warp will not occur. Thus, the step of applying a layer of preventer in firing process to prevent from the edge curl of electrode in conventional solution can be saved and the steps of producing process and process cost can be greatly reduced.

What is described above is only preferred embodiments of the invention, not to confine the scope of claims of the invention; the equivalent changes or modifications made within the spirit disclosed by the invention should be included in the appended claims.